STAINLESS STEEL POWDER FOR HIGH TEMPERATURE APPLICATIONS

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The invention pertains to the field of metal powder. More particularly, the invention pertains to a metal powder for high temperature applications.

DESCRIPTION OF RELATED ART

In the automobile industry there is a constant need for metal manufactured parts that can withstand and have a long wear life in high temperatures, resistant to corrosion and have a high tensile strength. One example of a composition used to achieve the above properties is US 3,620,690 which discloses a powder of 16 to 26 weight percent chromium, 6 to 22 weight percent nickel, 0.03-0.25 weight percent carbon, 1.75 to 4.0 weight percent of molybdenum, and small amounts of titanium, tantalum, and niobium. The powder is then compacted under a pressure of 2 to 100 tsi and then sintered at 2192 to 2552°F for 10 to 90 minutes. The sintering takes place in a reducing atmosphere (i.e. hydrogen and anhydrous or cracked ammonia), a vacuum, or an inert gas such as argon. Lastly, the compact undergoes rapid cooling.

Another example is US 3,953,201 which discloses a powder of 10.5 to 19 weight percent chromium, up to 0.0.3 weight percent carbon, up to 0.2 weight percent manganese, up to 0.2 weight percent silicon, up to 0.3 weight percent nickel, up to 0.1 weight percent aluminum, up to 0.2 weight percent copper, and at least one element from the group of titanium, and molybdenum where titanium is 4 (%C+%N) and molybdenum is 0.5-2.5 weight percent. The powder was heated at various temperatures using various methods of heating to improve corrosion resistance and increase ductility.

US 4,220,689 discloses a powder of 13 to 19 weight percent chromium, 13 to 19 weight percent nickel, 0.5 to 4.0 weight percent manganese, 3.5 to 7.0 weight percent silicon, up to 0.15 weight percent carbon, less than 0.04 weight percent nickel, 0.05 weight percent phosphorus, and 0.05 weight percent sulfur. The balance between the elements

silicon, chromium, nickel manganese, and nitrogen is essential for the desired properties of stress corrosion resistance, high temperature oxidation resistance, high work hardening rate, and galling resistance.

US 5,302,214 discloses up to 0.03 weight percent carbon, 0.1-0.8 weight percent silicon, 0.6 to 2.0 weight percent manganese, 0-0.006 weight percent sulfur, up to 4.0 weight percent nickel, 17 to 25 weight percent chromium, 0.2 to 0.8 weight percent niobium, 1 to 4.5 weight percent molybdenum, 0.1 to 2.5 weight percent copper, up to 0.03 weight percent nitrogen, and other elements. Furthermore, the ratio between the weight percent of manganese and sulfur is no less than 200, and niobium is defined by Nb% -8 (C%+N%) is not less than 0.2, and (Ni%+Cu%) is not more than 4. The powder has an improved low temperature toughness and a high resistance to weld cracking at high temperatures.

US 5,110,544 discloses a powder of not more than 0.010 weight percent carbon, not more than 0.2 weight percent silicon, 0.05 to 1.5 weight percent manganese, 12-20 weight percent chromium, 0.2 to 3.0 weight percent molybdenum, 0.005-0.1 weight percent aluminum, not more than 0.015 weight percent nitrogen, not more than 0.025 weight percent phosphorus, not more than 0.010 weight percent sulfur, either or both of 10*(C %+N %)-0.5% Ti and 5 *(C %+N %) 0.5% Nb. The powder displays anticorrosion properties.

US 6,342,087 discloses a process for producing low oxygen, essentially carbon free stainless steel powder which is produced by preparing molten steel in which contains 10 to 30 weight percent chromium, 0 to 5 weight percent molybdenum, 0 to 15 weight percent nickel, 0 to 1.5 weight percent silicon, 0 to 1.5 weight percent manganese, 0 to 2 weight percent niobium, 0 to 2 weight percent titanium, and 0 to 2 weight percent vanadium. The powder is heated to a temperature of at least 1120°C in a reducing atmosphere.

US 6,365,095 discloses a powder including 10 to 30 weight percent of chromium, 0 to 5 weight percent of molybdenum, 0 to 15 weight percent of nickel, 0 to 0.5 weight percent of silicon, 0 to 1.5 weight percent of manganese, 0 to 2 weight percent of niobium, 0 to 2 weight percent of titanium, 0 to 2 weight percent of vanadium, 0 to 5 weight percent

of Fe.sub.3 P, 0 to 0.4 weight percent graphite and at most 0.3 weight percent of inevitable impurities and most preferably 10 to 20 weight percent of chromium, 0 to 3 weight percent of molybdenum, 0.1 to 0.3 weight percent of silicon, 0.1 to 0.4 weight percent of manganese, 0 to 0.5 weight percent of niobium, 0 to 0.5 weight percent of titanium, 0 to 0.5 weight percent of vanadium, 0 to 0.2 weight percent of graphite and essentially no nickel or alternatively 7 to 10 weight percent of nickel, the balance being iron and unavoidable impurities. The powder is then combined with a lubricant and optionally a binding agent and heated to a temperature of 80 to 150°C., preferably 100 to 120°C. The heated mixture is then compacted in a tool heated to 80 to 130°C, preferably 100 to 120°C. The compact is sintered at temperatures between 1100 to 1300°C in a standard non-oxidative atmosphere for periods between 15 and 90, preferably between 20 and 60 minutes.

SUMMARY OF THE INVENTION

A method of producing parts from powdered metal comprising the steps of providing a metallurgic powder comprising iron, 0-0.6 weight percent carbon, 0.5-5.0 weight percent silicon, 0.5-6.0 weight percent nickel, 0.5-1.5 weight percent molybdenum, 0-0.7 weight percent manganese, and 12-20 weight percent chromium, the weight percentages calculated based on the total weight of the powder. Secondly, the powders are compressed at a pressure of 35 to 65 tsi to provide a green compact. Then, the compact is heated in an atmosphere to a temperature of 2100°F to 2400°F for 20 to 90 minutes, such that the resulting microstructure of the compact is either single phase ferritic or dual phase ferritic and austenitic.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 shows a block diagram showing the steps of the present invention to produce metal parts from powder that has high temperature applications.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a method for producing metal parts that have high temperature and corrosive applications. Figure 1 is a block diagram that shows the method

of producing metal parts. In the first step a mixture of metallurgical powder consisting of iron, 0-0.6 weight percent carbon, 12-20 weight percent chromium, 0.5-6.0 weight percent nickel, 0.5-1.5 weight percent molybdenum, 0-0.7 weight percent manganese, and 0.5-5.0 weight percent silicon is combined, see Table 1.

Table 1

	Fe	**C**	**Si**	**Ni**	**Mo**	**Mn**	**Cr**
New Powder	Balance	0-0.6	0.5-5.0	0.5-6.0	0.5-1.5	0-0.7	12-20

In the second step the mixture of powders is compacted with a compaction pressure in the range of 35 to 65 tsi, resulting in a compact with a green density of 6.0 to7.0g/cc. The green compact is then sintered in a H_2, N_2/H_2, or a vacuum atmosphere at a temperature in the range of 2100°F to 2400°F for 20 to 90 minutes.

Lastly, a secondary heating or other operation may be applied to the compact depending upon the required mechanical properties. The resulting microstructure is either dual phase Ferritic and Austinic or single phase Ferritic. The duplex microstructure gives the compact a higher corrosion resistance due to the lower impurity concentration level on grain boundaries. The compact also has high hot tensile strength due to the smaller grain size and the increased difficulty of dislocation motion through grain boundaries. For example, the tensile strength of the compact at 1200°F is up to 28 ksi and the tensile strength of the same compact at room temperature is up to 115 ksi.

Example 1

The application required a finished material that would be formed into vane rings and used in a variable turbine geometry (VTG) turbocharger. Numerous design considerations were taken into account for the formation of the vane rings. The vane rings had to perform at elevated temperatures in the range of 1000°F to 1600°F and include hardness/wear resistance, ultimate tensile strength, and a decreased amount of elongation

at the elevated temperatures. Since the vane rings are attached to a housing and act as bearing surfaces for the movement of the vanes and the vane levers in the turbocharger, the vane rings have to allow for free movement of the vanes while still controlling the position of the vanes accurately over the life of the turbocharger. Lastly, the design of the vane rings had to be different from the vane and vane levers to prevent welding. The stainless steel powder composition to make the vane rings consisted of iron, 14 weight percent chromium, 4 weight percent nickel, 3 weight percent silicon, and 0.5 weight percent molybdenum. The mixture was then pressed at a compaction pressure of 50 tsi and then sintered in a hydrogen atmosphere at 2350°F for 40 minutes.

Accordingly, it is to be understood that the embodiments of the invention herein described are merely illustrative of the application of the principles of the invention. Reference herein to details of the illustrated embodiments is not intended to limit the scope of the claims, which themselves recite those features regarded as essential to the invention.